Machine for producing metal strips by continuous casting, particularly for producing very wide metal strips

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Cited documents:

- GB861273
- GB1388378
- EP0108926
- EP0289433
- WO9304801

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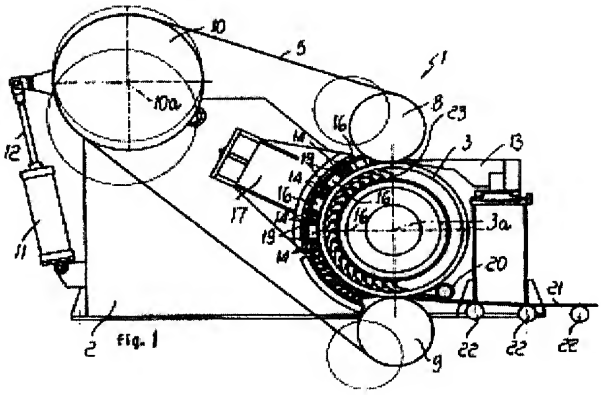
Abstract of **EP0798060**

A machine for producing metal strips by continuous casting, particularly for producing very wide metal strips, the machine comprising: a drum (3), with a horizontal axis (3a) and rotatable about its own axis (3a), having, on its lateral surface, a recess (4) which forms the bottom (4a) and two mutually opposite side walls (4b, 4c) of a continuous-casting die; a continuous belt (5), running along a closed path and wrapping, for part of its extension, around a portion of the lateral surface of the drum (3), resting on the edges (6, 7) that delimit the recess (4) in order to close the continuous-casting die; tensioning means (10, 11) which act on the belt (5); means (13) being provided for conveying molten metal into the continuous-casting die in the region closed by the continuous belt (5), as well as means (14, 23) for cooling the regions of the continuous belt (5) and of the drum (3) which are in contact with the metal conveyed into the continuous-casting die. The continuous belt (5) is made of a material that can be polarized magnetically, and means (16) are provided for generating a magnetic field affecting the continuous belt (5) over at least part of its region which is in contact with the drum (3) starting from the region where the molten metal is cast into the continuous-casting die, in order to contrast, by means of magnetic forces, a deformation of the continuous belt (5), keeping it parallel to the outer lateral surface of the drum (3).



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(54) Machine for producing metal strips by continuous casting, particularly for producing very wide metal strips

(57) A machine for producing metal strips by continuous casting, particularly for producing very wide metal strips, the machine comprising: a drum (3), with a horizontal axis (3a) and rotatable about its own axis (3a), having, on its lateral surface, a recess (4) which forms the bottom (4a) and two mutually opposite side walls (4b, 4c) of a continuous-casting die; a continuous belt (5), running along a closed path and wrapping, for part of its extension, around a portion of the lateral surface of the drum (3), resting on the edges (6, 7) that delimit the recess (4) in order to close the continuous-casting die; tensioning means (10, 11) which act on the belt (5); means (13) being provided for conveying molten metal into the continuous-casting die in the region closed by the continuous belt (5), as well as means (14, 23) for cooling the regions of the continuous belt (5) and of the drum (3) which are in contact with the metal conveyed into the continuous-casting die. The continuous belt (5) is made of a material that can be polarized magnetically, and means (16) are provided for generating a magnetic field affecting the continuous belt (5) over at least part of its region which is in contact with the drum (3) starting from the region where the molten metal is cast into the continuous-casting die, in order to contrast, by means of magnetic forces, a deformation of the continuous belt (5), keeping it parallel to the outer lateral surface of the drum (3).

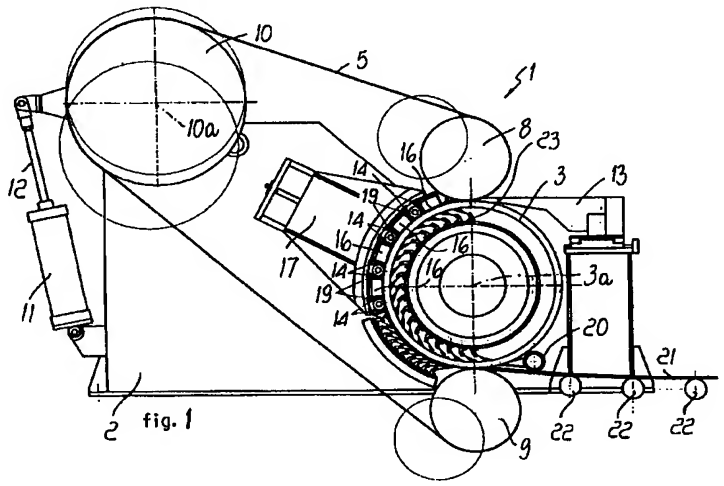

fig. 1

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Description

The present invention relates to a machine for producing metal strips by continuous casting, particularly for producing very wide metal strips.

Among conventional methods for producing wide metal strips by continuous casting, leaving aside those based on fixed or oscillating dies, mention can be made of those using continuous moving dies, such as for example the Hunter method, which provides for casting between two cooled cylinders, or the Hazelett method, which is based on casting between two cooled steel strips arranged like two tracks so as to overlap with respect to each other, or also such as the Launer method, which provides for casting between two tracks but wherein each track is formed by a chain of bars/blocks having a quadrangular or rectangular cross-section which absorb the solidification heat of the cast metal and are cooled after losing contact with the product.

In rare cases, metal strips obtained by continuous casting have been manufactured with the method known as "wheel and belt", which is instead used extensively for the production of bars having a trapezoidal cross-section. This method uses a casting machine provided with two wheels arranged on a vertical plane. The lower wheel has, on its lateral surface, a peripheral groove which is closed by a belt welded end to end and tensioned on the lower wheel by the upper wheel. The peripheral groove of the rotating lower wheel and the belt form a continuous casting die which is cooled by sprayers located inside the lower wheel and outside the belt, thus solidifying the liquid metal poured into the continuous die.

A machine of this kind is disclosed for example in British patent 1,015,984. The basic concept of the wheel-and-belt machine has subsequently been reused by differently placing the pulley or pulleys used to press and/or tension said belt. Two improvements of this kind, devised by Rigamonti and Mann, are described by D.M. Lewis in Metallurgical Reviews 1961, vol. 6, no. 22, page 158, and in Aluminium 37 (1961), no. 4, S 209/14.

The wheel-and-belt method has, with respect to methods using two cylinders, the advantage that it allows very high hourly production rates, since the heat exchange surface for dissipating the molten metal heat is considerably larger. With respect to methods using two superimposed track-shaped belts or two tracks with bars/blocks, the wheel-and-belt method is cheaper in terms of investment and easier to manage.

All the variations of the method based on using a wheel-and-belt machine, however, have so far not become widespread because the obtainable strip is very limited in width. The up to now unsurmountable problem was the insufficient flatness of the resulting strip, which is unacceptable because of the considerable warping of the continuous steel belt forming one side of the continuous die and resting on the wheel only at its lateral edges. For widths in the range of 300 mm and more, the belt no longer maintains the necessary flatness owing to two basic reasons: the tension required to keep the belt in close contact with the edges of the wheel, so as to hermetically close the solidification chamber or continuous die, and the deformation of the steel belt owing to the expansion caused by the heating produced by the molten or freshly solidified metal which makes direct contact with said belt.

A principal aim of the present invention is to provide a continuous casting machine of the wheel-and-belt type which can produce even very wide metal strips without causing flatness problems in the manufactured metal strip.

Within the scope of this aim, an object of the present invention is to provide a machine which can use the technology of continuous-casting machines of the wheel-and-belt type for the production of bars having a trapezoidal cross-section, which has been used and refined for years, ensuring high quality of the resulting metal strip.

Another object of the invention is to provide a machine allowing to produce metal strips, particularly very wide metal strips, with a very high hourly production rate.

Another object of the invention is to provide a machine which, through its high productivity, can feed, if required, an in-line rolling unit, fully utilizing its production capacity.

This aim, these objects, and others which will become apparent hereinafter are achieved by a machine for producing metal strips by continuous casting, particularly for producing very wide metal strips, comprising: a drum, with a horizontal axis and rotatable about said axis, having, on its lateral surface, a recess that forms the bottom and two mutually opposite side walls of a continuous-casting die; a continuous belt, running along a closed path and wrapping, for part of its extension, around a portion of the lateral surface of said drum, resting on the edges that delimit said recess to close said continuous-casting die; means for tensioning said belt; means for conveying molten metal inside said continuous-casting die in the region affected by said continuous belt; means for cooling the regions of said belt and of said drum which are in contact with the metal conveyed into said continuous-casting die; characterized in that said continuous belt is made of a material that can be polarized magnetically and in that it comprises means for generating a magnetic field affecting said continuous belt over at least part of its region which is in contact with said drum starting from the region where the molten metal is cast into said continuous-casting die, in order to contrast, by means of magnetic forces, a deformation of said continuous belt, keeping it parallel to the outer lateral surface of said drum.

Further characteristics and advantages of the invention will become apparent from the following detailed description of a preferred but not exclusive embodiment of the machine according to the invention, illustrated only by way of non-limitative example in the

accompanying drawings, wherein:

figure 1 is a schematic lateral elevation view of the machine according to the present invention;

figure 2 is a schematic enlarged-scale view of a detail of figure 1;

figure 3 is a schematic sectional view of figure 2, taken along the plane III-III.

With reference to the above figures, the machine according to the invention, generally designated by the reference numeral 1, comprises a footing 2 supporting a drum 3 which has a horizontal axis 3a and is rotatable about said axis 3a.

The drum 3 has, on its lateral surface, a recess 4 forming the bottom 4a and two mutually opposite side walls 4b and 4c of a continuous-casting die.

The drum 3 can be actuated about its own axis 3a by means of a conventional gearmotor which is not illustrated for the sake of simplicity.

The machine also comprises a continuous belt 5 running along a closed path and winding, for part of its extension, around part of the lateral surface of the drum 3, resting on the edges 6 and 7 which laterally delimit the recess 4 and thus closing the continuous-casting die.

More particularly, the belt 5 winds around three pulleys 8, 9, and 10 which are arranged so that their axes are parallel to the axis 3a of the drum 3.

The pulleys 8, 9, and 10 are freely supported about their respective axes and the pulley 10 can shift, parallel to its own axis 10a, so as to vary the tension of the belt 5. This shift can be achieved, in a per se known manner, for example by means of a fluid-actuated cylinder 11 pivoted to the footing 2 with its body and acting, with the stem 12 of its piston, on the support of the pulley 10.

The pulley 8 is preferably arranged so as to be tangent to the upper end of the drum 3, whilst the pulley 9 is spaced with respect to the pulley 8 by an angle of substantially 180° with respect to the axis 3a, so as to be tangent to the lower end of the drum 3.

The machine also comprises means for conveying the molten metal into the continuous-casting die in the region affected by the belt 5. These conveyance means can be constituted, in a per se known manner, by one or more crucibles 13 pouring the molten metal into the continuous-casting die proximate to the upper end of the drum 3, i.e., in the region where the belt 5 starts to be tangent to the drum 3, so that the cast molten metal, as a consequence of the rotation of the drum 3 and of the consequent translatory motion of the belt 5 by friction, is entrained into the closed portion of the continuous-casting die.

In the region of the machine where tangency between the belt 5 and the drum 3 occurs, means are provided for cooling the regions of the belt 5 and of the drum 3 which make contact with the metal cast into the continuous-casting die.

The cooling means can be constituted, in a per se known manner, by a plurality of nozzles 23 arranged inside the drum 3 and directed towards the inner lateral surface of the drum and by nozzles 14 supported outside the drum 3 and directed towards the side of the belt 5 which faces away from the drum 3.

The nozzles 23 and 14 can be supplied with a pressurized fluid so as to deliver, according to requirements, a pressurized coolant or a mist of coolant and air.

According to the invention, the belt 5 is made of a material that can be polarized magnetically, such as for example mild or stainless steel of the ferromagnetic type. The belt 5 can also be constituted by a woven metal mesh according to requirements.

Also according to the invention, means are provided for generating a magnetic field affecting the belt 5 at least over part of the portion that is in contact with the drum 3 starting from the region where the molten metal is poured into the continuous-casting die, so as to contrast, by means of magnetic forces, the deformation of the belt 5, keeping belt 5 parallel to the outer lateral surface of the drum 3.

Said means for generating a magnetic field can be constituted, as shown in particular in figures 1 and 2, by magnetic bars 16 having a rectangular, square, or round cross-section, which are parallel to the axis 3a of the drum 3. The magnetic bars 16 and the nozzles 14 are mounted on a frame 17 movable on command towards or away from the axis 3a of the drum 3, for example through a screw 18, to allow replacement of the belt 5.

As an alternative, the bars 16 can be replaced with magnetic rollers having a small diameter which are supported by frame 17, so that they can rotate about their respective axes, which are parallel to the axis 3a, and can rotate about their own axes because of friction against the belt 5.

The means for generating a magnetic field can be constituted by electromagnets instead of by magnetic bars, i.e., permanent magnets.

The permanent magnets or electromagnets have an orientation of the magnetic field which is such as to apply centrifugal forces, i.e., forces directed away from the axis 3a of the drum 3, on the part of the belt 5 they face.

The magnetic bars or rollers can have a continuous structure or can be formed by a plurality of separate magnetic segments or by magnetized regions.

The magnetic bars 16 or the magnetic rollers used can have, on their side meant to rest against the opposite face of the belt 5 with respect to the drum, a coating layer made of a material having a low friction coefficient.

The magnetic bars or magnetic rollers, or other magnetic-field generation means used, are spaced one from the other on the frame 17 so as to allow the placement of the nozzles 14 and the downward flow of the coolant released by said nozzles. If a covering layer of material having a low friction coefficient is used between the belt 5 and the magnetic bars or other means for generating a magnetic field, it is possible to provide, in the layer of material having a low friction

coefficient, grooves for the flow of the coolant released by the nozzles 14.

Advantageously, at least on the part of the belt 5 affected by the magnetic field generated by the permanent magnets or electromagnets, pusher means are provided which act on the side of the belt 5 opposite to the drum 3 in order to keep the belt 5, over all its width, parallel to the cylindrical lateral surface of the drum 3.

The pusher means can be constituted, as shown, by a plurality of friction wheels 19 mounted in groups on shafts 20 which are supported by the frame 17 and are orientated so that their axes are parallel to the axis 3a.

As an alternative, the wheels 19 can be replaced with supporting sliding blocks or with balls or with other technically equivalent supporting means acting on the belt 5 in the opposite direction with respect to the force produced by the magnetic field generated by the above-mentioned permanent magnets or electromagnets.

For the sake of completeness of description, it should be noted that, proximate to the pulley 9 and laterally to the drum 3, there is provided, in a per se known manner, a baffle element 20 which separates the metal strip 21, produced by the solidification of the metal cast into the continuous-casting die, from the drum 3 and moves it away from said drum 3.

The operation of the machine according to the invention is as follows.

The liquid metal is cast, by means of the crucible 13, at the upper end of the drum 3 in the continuous-casting die delimited by the belt 5 and by the drum 3, which is rotated about its own axis counterclockwise in figures 1 and 2.

As a consequence of the rotation of the drum 3, the belt 5 is moved by friction and the molten metal starts to solidify as it advances from the upper end of the drum 3 towards the lower end.

From the point where the metal is introduced in the continuous-casting die and along part of its extension against the drum 3, the belt 5, by making contact with the molten or freshly solidified metal, is subjected to considerable heating, which would cause expansion of the layers of the belt 5 that are in direct contact with the molten or freshly solidified metal, this expansion being greater than the expansion on the side directed away from the drum and cooled. This expansion, together with the tension whereto the portion of belt 5 wound around the drum 3 is subjected, would cause an undesirable deformation of the belt 5 towards the axis 3a of the drum 3, with a consequent deformation of the metal strip being cast.

The presence at said part of the belt 5 of permanent magnets or of electromagnets which generate, on the belt 5, a force directed away from the axis 3a effectively contrasts this deformation, keeping the belt 5 parallel to the outer lateral surface of the drum 3 and thus allowing to obtain a cast strip having excellent flatness or in any case a flatness that is acceptable and compatible with any subsequent treatment.

Since the magnetic force applied by the permanent magnets or electromagnets to the belt 5 is difficult to control, the wheels 19, by providing supporting points for the side of the belt 5 which is opposite with respect to the drum 3, have the effect of avoiding deformation of the belt 5 away from the axis 3a, thus allowing to use without problems a higher magnetic force than theoretically required to contrast the deformation of the belt 5 towards the axis 3a.

When leaving the drum 3, the strip 21 produced by the solidification of the molten metal introduced in the continuous-casting die is moved away by the baffle element 20 which is laterally adjacent to the drum 3 proximate to the pulley 9. The strip 21 is then conveyed on rollers 22 towards gathering, cutting, or rolling processes.

In practice it has been observed that the machine according to the invention fully achieves the intended aim, since it allows to continuously produce strips with a width that can vary between 300 mm and 1000 mm and more, with excellent flatness on both sides, nonetheless maintaining the typical advantages of wheel-and-belt continuous-casting machines.

The machine thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept; thus, for example, the magnetic field generation means can be provided by using studs or tracks with ferrite or neodymium magnets which can assume both substantially linear configurations, and thus be arranged parallel to the axis 3a of the drum 3, and curved configurations, allowing great freedom in terms of spatial arrangement, or by using a plurality of permanent magnets or electromagnets in the form of small plates or cylinders of alnico, ferrite, or neodymium.

All the details may also be replaced with other technically equivalent elements.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A machine for producing metal strips by continuous casting, particularly for producing very wide metal strips, comprising: a drum, with a horizontal axis and rotatable about said axis, having, on its lateral surface, a recess which forms the bottom and two mutually opposite side walls of a continuous-casting die; a continuous belt, running along a closed path and wrapping, for part of its extension, around a portion of the lateral surface of said drum, resting on the edges that delimit said recess to close said continuous-casting die; means for tensioning said belt; means for conveying molten metal inside said continuous-casting die in the region affected by

said continuous belt; means for cooling the regions of said belt and of said drum which are in contact with the metal conveyed into said continuous-casting die; characterized in that said continuous belt is made of a material that can be polarized magnetically and in that it comprises means for generating a magnetic field affecting said continuous belt over at least part of its region which is in contact with said drum starting from the region where the molten metal is cast into said continuous-casting die, in order to contrast, by means of magnetic forces, a deformation of said continuous belt, keeping it parallel to the outer lateral surface of said drum.

2. A machine according to claim 1, characterized in that said means for generating a magnetic field are arranged so as to apply to said part of the continuous belt forces orientated away from the axis of said drum.

3. A machine according to claim 1, characterized in that said means for generating a magnetic field are constituted by permanent magnets.

4. A machine according to claim 1, characterized in that said means for generating a magnetic field are constituted by electromagnets.

5. A machine according to claim 3, characterized in that said permanent magnets are shaped like straight bars arranged parallel to the axis of said drum along an imaginary cylindrical surface which is parallel to the lateral surface of said drum which is affected by said part of the continuous belt.

6. A machine according to claim 5, characterized in that said permanent magnets shaped like straight bars slide on the side of said continuous belt which is opposite to said drum, a layer of material with a low friction coefficient being interposed.

7. A machine according to claim 3, characterized in that said permanent magnets are shaped like rollers with axes which are arranged parallel to the axis of said drum and make contact with the side of said continuous belt which is opposite with respect to said drum, said roller-shaped permanent magnets being rotatably supported about their axes and being rotatable by means of the friction caused by contact with said continuous belt.

8. A machine according to claim 3, characterized in that said permanent magnets are composed of magnetic segments spaced from one another or of magnetized regions.

9. A machine according to claim 1, characterized in that said cooling means comprise nozzles for spraying a coolant on the side of said portion of continuous belt lying opposite to said drum and on the region of said drum affected by said continuous belt portion.

10. A machine according to claim 9, characterized in that said coolant is constituted by a pressurized liquid.

11. A machine according to claim 9, characterized in that said coolant is constituted by a mist of coolant and air.

12. A machine according to claim 9, characterized in that said means for generating a magnetic field are spaced from each other along said continuous belt portion to allow the flow of the coolant released by said nozzles.

13. A machine according to claim 6, characterized in that grooves for the passage of the coolant released by said cooling means are formed in said layer of material having a low friction coefficient.

14. A machine according to claim 1, characterized in that it comprises pusher means acting on the side of the part of said continuous belt which is opposite with respect to said drum in order to keep said continuous belt against said drum in contrast with the action of said magnetic forces.

15. A machine according to claim 14, characterized in that said pusher means comprise friction wheels which are supported so that they can rotate about their respective axes, arranged parallel to the axis of said drum, said wheels making contact with the side of said part of the continuous belt that is opposite to said drum.

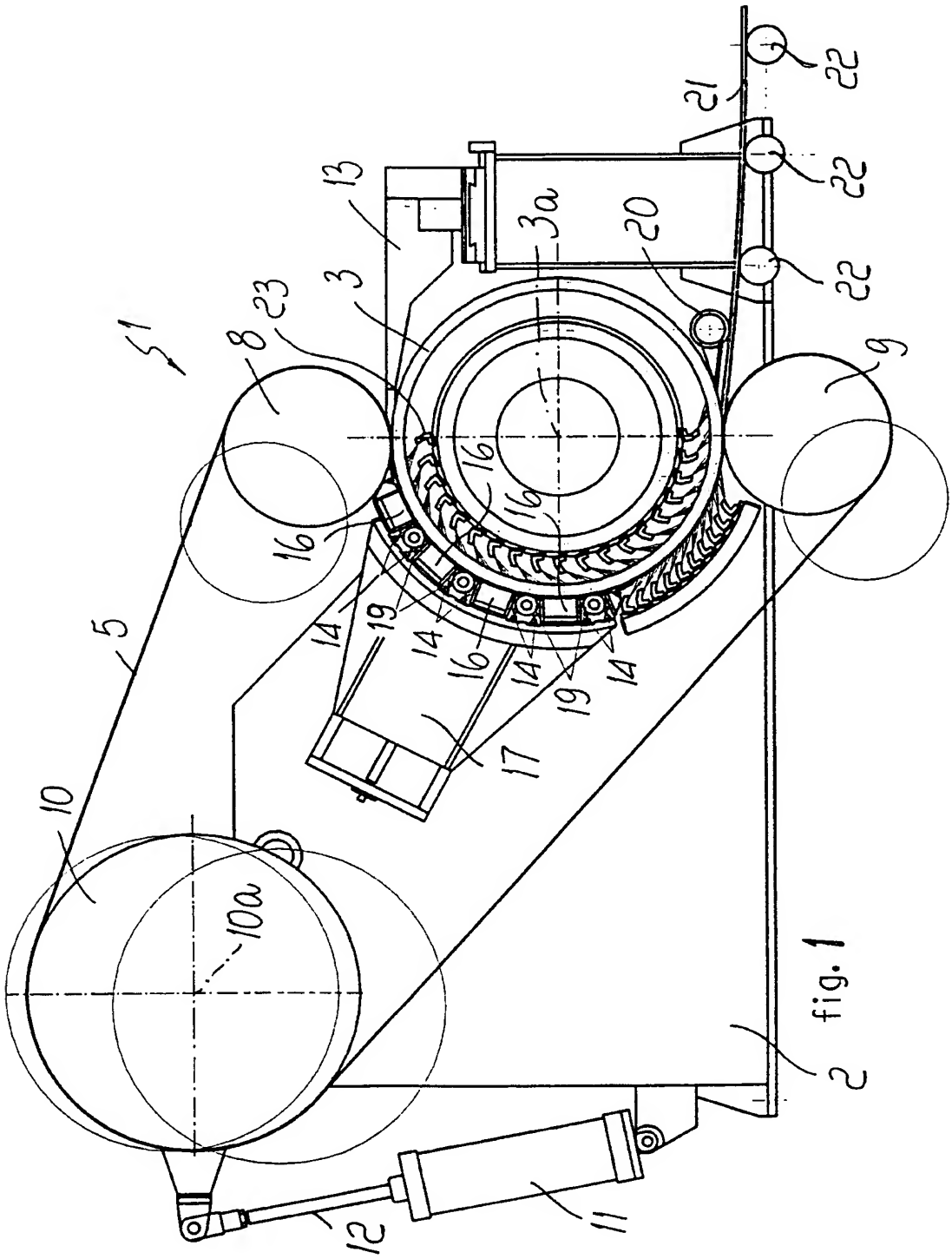

fig. 1

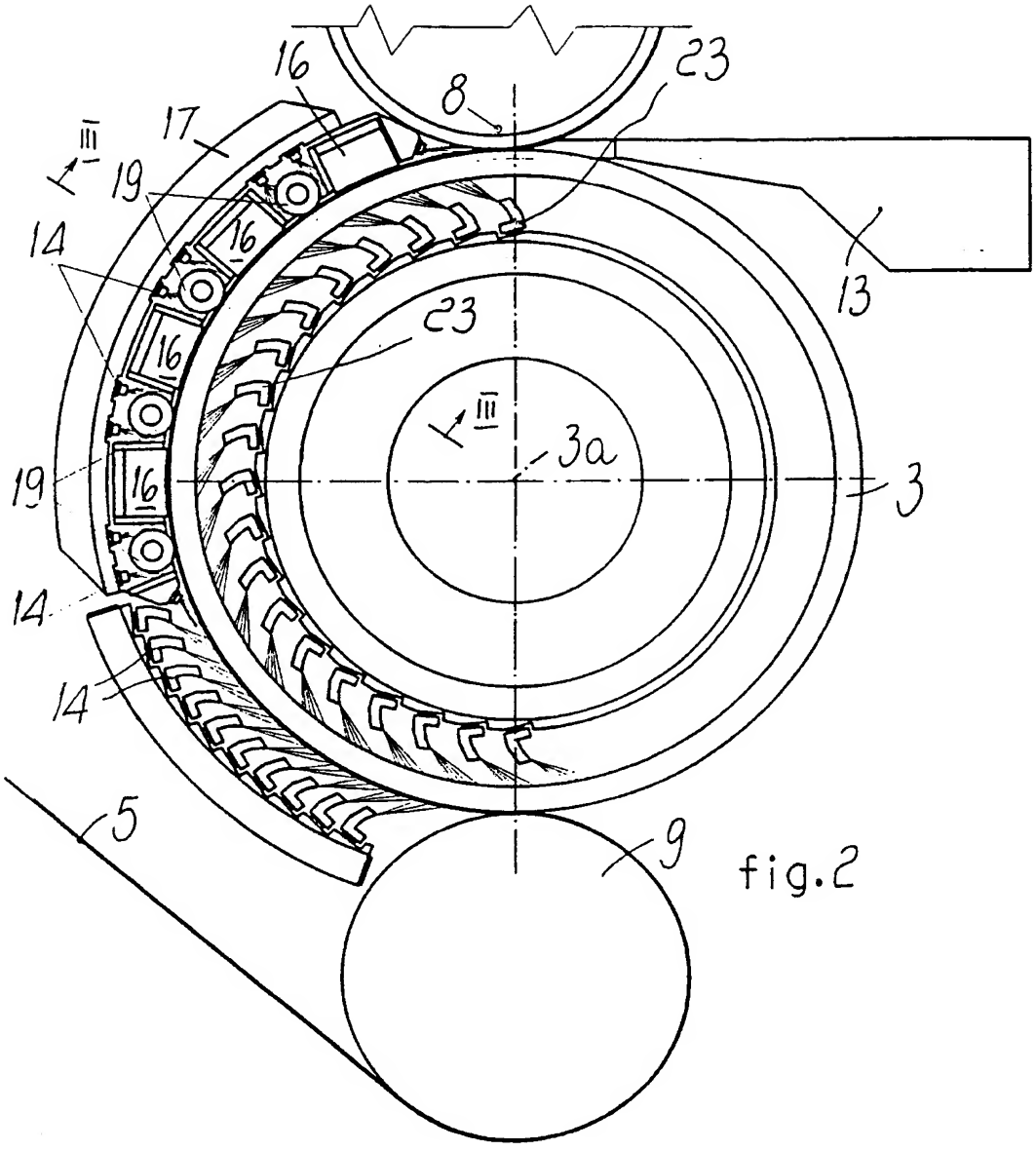

fig.2

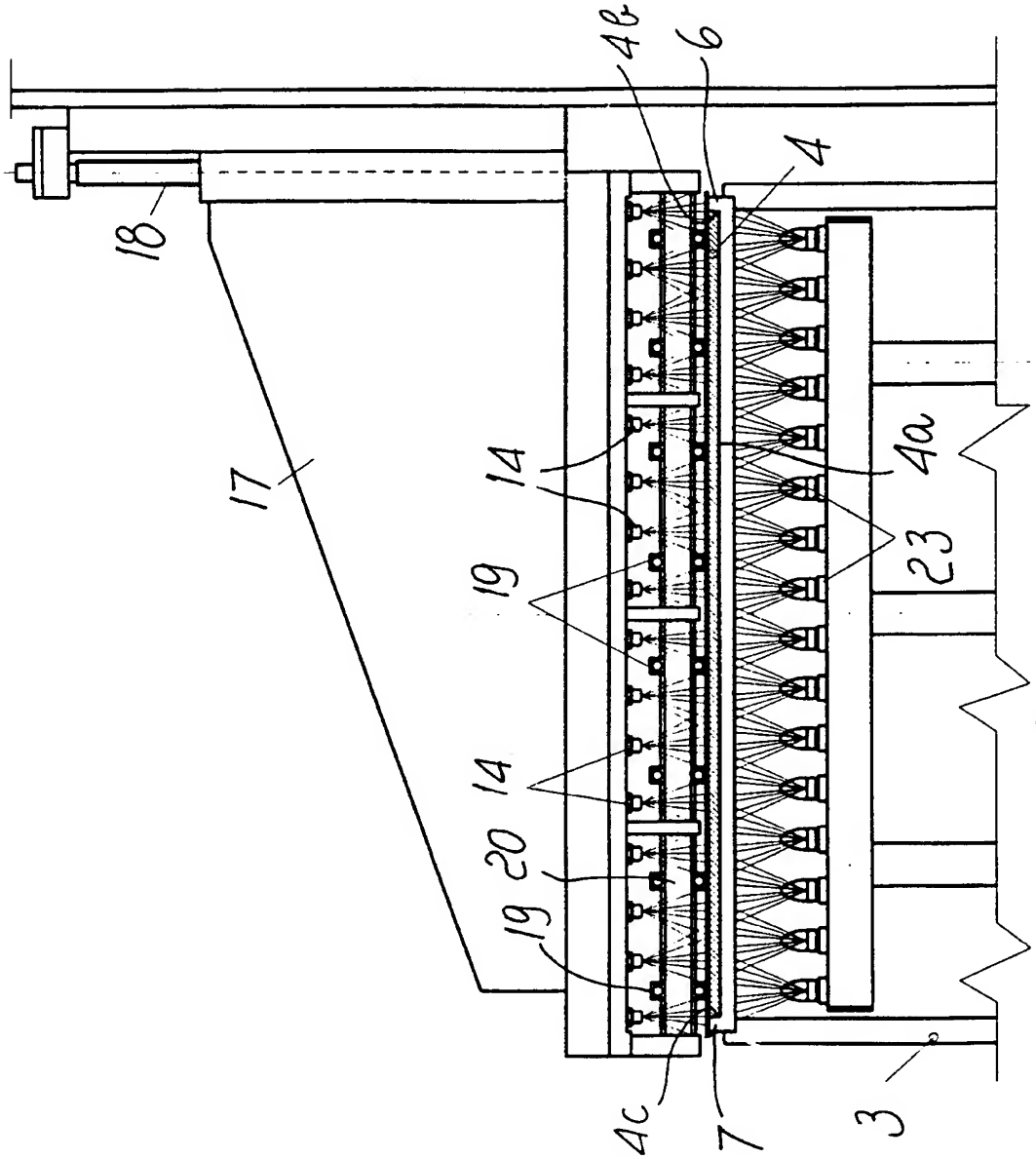

fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 97 10 3820

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A,D	ALUMINIUM, vol. 37, no. 4, 1961, DÜSSELDORF,DE, pages 209-214, XP002034983 H. W. BRAND: "Neue kontinuierliche Bandgiess- und -walzanlagen für Aluminium " * figure 1 *	1	B22D11/06
Y	GB 861 273 A (COMPAGNIE DES METAUX D'OVERPELT-LOMMEL ET DE CORPHALIE) * claim 1; figure 1 *	1	
Y	GB 1 388 378 A (ALCAN RESEARCH AND DEVELOPMENT LIMITED) * claim 1; figures 8-10 *	1	
A	EP 0 108 926 A (ALLIED CORPORATION) * claim 1 *	1	
A	EP 0 289 433 A (ALUMINIUM PECHINEY) * claim 1; figure 1 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	WO 93 04801 A (J. SZEKELY ET AL.) * claim 1 *	1	B22D
A	PATENT ABSTRACTS OF JAPAN vol. 008, no. 234 (M-334), 26 October 1984 & JP 59 113958 A (HITACHI SEISAKUSHO KK), 30 June 1984, * abstract *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	11 July 1997	Sutor, W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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